From this I infer that two hundred to three hundred years ago the deer, elk and buffalo in their many wanderings across streams and over hills, have occasionally carried in their hoofs partly sprouted seeds, and dropped them on the hills where the sunshine was unobstructed, and the trees thus got their footing, and once getting it were able to stand afterward. These are the only kinds of trees I have observed, but I presume a similar law governs the distribution and self-planting of them all.

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ON THE EVOLUTION OF THE VERTEBRATA, PROGRESSIVE AND RETROGRESSIVE.

BY E. D. COPE.

(Continued from page 247, March number.)

THE REPTILIAN LINE—CONTINUED.

IN the first place, this line departs with lapse of time from the primitive and ancestral order, the Theromorpha, in two respects. First in the loss of the capitular articulation of the ribs, and second in the gradual elongation and final freedom of the suspensory bone of the lower jaw (the os quadratum). In so departing from the Theromorpha, it also departs from the mammalian type. The ribs assume the less perfect kind of attachment which the mammals only exhibit in some of the whales, and the articulation of the lower jaw loses in strength, while it gains in extensibility, as is seen in the development of the line of the eels among fishes. The end of this series, the snakes, must therefore be said to be the result of a process of creation by degeneration, and their lack of scapular arch and fore limb and usual lack of pelvic arch and hind limb are confirmatory evidence of the truth of this view of the case.

Secondly, as regards the ossification of the anterior part of the brain-case. This is deficient in some of the Theromorpa, the ancestral order, which resemble in this, as in many other things, the cotemporary Batrachia. Some of them, however (Diadectidæ), have the brain completely enclosed in front. The late orders mostly have the anterior walls membranous, but in the streptostylicate series at the end, the skull becomes entirely closed in front. In this respect then the snakes may be said to be the highest or most perfect order.

As regards the scapular arch, no order possesses as many ele-

ments as thoroughly articulated for the use of the anterior leg as the Permian Theromorpha. In all the orders there is loss of parts, excepting only in the Ornithosauria and the Lacertilia. In the former the adaptation is to flying. The latter retain nearly the Theromorph type. An especial side development is the modification of abdominal bones into two peculiar elements to be united with the scapular arch into a plastron, seen in the Testudinata. In this part of the skeleton the orders are generally degenerate, the last one, the Ophidia, especially so.

The pelvic arch has a more simple history. Again in the Theromorpha we have the nearest approach to the Mammalia. The only other order which displays similar characters is the Ornithosauria (Dimorphodon, according to Seeley). In the Dinosauria we have a side modification which is an adaptation to the erect or bipedal mode of progression, the inferior bones being thrown backwards so as to support the viscera in a more posterior position. This is an obvious necessity to a bipedal animal where the vertebral column is not perpendicular, as in birds. And it is from the Dinosauria that the birds are supposed to have arisen. The main line of the Reptilia, however, departs from both the mammalian and the avian type and loses in strength. In the latest orders, the Pythonomorpha and Ophidia, the pelvis is rudimental or absent.

As regards the limbs, the degeneracy is well marked. No reptilian order of later ages approaches so near to the Mammalia in these parts as do the Permian Theromorpha. This approximation is seen in the internal epicondylar foramen and well developed condyles of the humerus, and in the well differentiated seven bones of the tarsus. The epicondylar foramen is only retained in later reptiles in the Rhynchocephalian Hatteria (Dollo); and the condyles of the Dinosauria and all of the other orders, excepting the Ornithosauria and some Lacertilia, are greatly wanting in the strong characterization seen in the Theromorpha. The posterior foot seems to have stamped out the greater part of the tarsus in the huge Dinosauria, and it is reduced, though to a less degree, in all the other orders. In the paddled Sauropterygia, dwellers in the sea, the tarsus and carpus have lost all characterization, probably by a process of degeneracy, as in the mammalian whales. This is to be inferred from the comparatively late period of their appearance in time. The

still more unspecialized feet and limbs of the Ichthyosaurus (Ichthyopterygia) cannot yet be ascribed to degeneracy, for their history is too little known. At the end of the line the snakes present us with another evidence of degeneracy. But few have a pelvic arch (Stenostomidæ Peters), while very few (Peropoda) have any trace of a posterior limb.

The vertebræ are not introduced into the definitions of the orders, since they are not so exclusively distinctive as many other parts of the skeleton. They nevertheless must not be overlooked. As in the Batrachia the Permian orders show inferiority in the deficient ossification of the centrum. Many of the Theromorpha are notochordal, a character not found in any later order of reptiles excepting in a few Lacertilia (Gecconidæ). They thus differ from the Mammalia, whose characters are approached more nearly by some of the terrestrial Dinosauria in this respect. Leaving this order we soon reach the prevalent ball and socket type of the majority of Reptilia. This strong kind of articulation is a need which accompanies the more elongated column which itself results at first from the posterior direction of the ilium. In the order with the longest column, the Ophidia, a second articulation, the zygosphen, is introduced. The mechanical value of the later reptilian vertebral structure is obvious, and in this respect the class may be said to present a higher or more perfect condition than the Mammalia.

In review it may be said of the reptilian line, that it exhibits marked degeneracy in its skeletal structure since the Permian epoch; the exception to this statement being in the nature of the articulations of the vertebræ. And this specialization is an adaptation to one of the conditions of degeneracy, viz., the weakening and final loss of the limbs and the arches to which they are attached.

The history of the development of the brain in the Reptilia presents some interesting facts. In the Diadectid family of the Permian Theromorpha it is smaller than in a *Boa constrictor*, but larger than in some of the Jurassic Dinosauria. Marsh has shown that some of the latter possess brains of relatively very narrow hemispheres, so that in this organ those gigantic reptiles were degenerate, while the existing streptostylicate orders have advanced beyond their Permian ancestors.

There are many remarkable cases of what may now be safely

called degradation to be seen in the contents of the orders of reptiles.[1] Among tortoises may be cited the loss of the rib-heads and of one or two series of phalanges in the especially terrestrial family of the Testudinidæ. The cases among the Lacertilia are the most remarkable. The entire families of the Pygopodidæ, the Aniellidæ, the Anelytropidæ and the Dibamidæ are degraded from superior forms. In the Anguidæ, Teïdæ and Scincidæ we have series of forms whose steps are measured by the loss of a pair of limbs, or of from one to all the digits, and even to all the limbs. In some series the surangular bone is lost. In others the eye diminishes in size, loses its lids, loses the folds of the epidermis which distinguish the cornea, and finally is entirely obscured by the thickening of the cornea and closure of the ophthalmic orifice in the true skin. Among the snakes a similar degradation of the organs of sight has taken place in the order of the Scolecophidia, which live under ground, and often in ants' nests. The Tortricidæ and Uropeltidæ are burrowing snakes which display some of the earlier stages of this process. One genus of the true snakes even (according to Günther) has the eyes obscured as completely as those of the inferior types above named (genus Typhlogeophis).

VII. The Avian Line.

The palæontology of the birds not being well known, our conclusions respecting the character of their evolution must be very incomplete. A few lines of succession are, however, quite obvious, and some of them are clearly lines of progress, and others are lines of retrogression. The first bird we know at all completely, is the celebrated Archeopteryx of the Solenhofen slates of the Jurassic period. In its elongate series of caudal vertebræ and the persistent digits of the anterior limbs we have a clear indication of the process of change which has produced the true birds, and we can see that it involves a specialization of a very pronounced sort. The later forms described by Seeley and Marsh from the Cretaceous beds of England and North America, some of which have biconcave vertebræ, and all probably, the American forms certainly, possessed teeth. This latter character was evidently speedily lost, and others more characteristic of the subclass became the field of developmental change. The parts

[1] Such forms in the Lacertilia have been regarded as degradational by Lankester and Boulanger.

which subsequently attained especial development are the wings and their appendages; the feet and their envelopes, and the vocal organs. Taking all things into consideration the greatest sum of progress has been made by the perching birds, whose feet have become effective organs for grasping, whose vocal organs are most perfect and whose flight is generally good, and often very good. In these birds also the circulatory system is most modified, in the loss of one of the carotid arteries.

The power of flight, the especially avian character, has been developed most irregularly, as it appears in all the orders in especial cases. This is apparent so early as in the Cretaceous toothed birds already mentioned. According to Marsh the Hesperornithidæ have rudimental wings, while these organs are well developed in the Ichthyornithidæ. They are well developed among natatorial forms in the albatrosses and frigate pelicans, and in the skuas, gulls and terns; among rasorial types the sand-grouse, and among the adjacent forms, the pigeons. Then among the lower insessores, the humming-birds exceed all birds in their powers of flight, and the swifts and some of the Caprimulgidæ are highly developed in this respect. Among the higher or true song birds, the swallows form a notable example. With these high specializations occur some remarkable deficiencies. Such are the reduction of the feet in the Caprimulgidæ swifts and swallows, and the fœtal character of the bill in the same families. In the syndactyle families, represented by the kingfishers, the condition of the feet is evidently the result of a process of degeneration.

A great many significant points may be observed in the developmental history of the epidermic structures, especially in the feathers. The scale of change in this respect is in general a rising one, though various kinds of exceptions and variations occur. In the development of the rectrices (tail feathers) there are genera of the wading and rasorial types, and even in the insessorial series, where those feathers are greatly reduced or absolutely wanting. These are cases of degeneracy.

There is no doubt but that the avian series is in general an ascending one.

VIII. The Mammalian Line.

Discoveries in palæontology have so far invalidated the accepted definitions of the orders of this class that it is difficult to

give a clearly cut analysis, especially from the skeleton alone. The following scheme, therefore, while it expresses the natural groupings and affinities, is defective in that some of the definitions are not without exceptions :

I. A large coracoid bone articulating with the sternum.

Marsupial bones; fibula articulating with proximal end of astragalus
1. *Monotremata.*

II. Coracoid a small process coössified with the scapula.

a. Marsupial bones; palate with perforations (vagina double; placenta and corpus callosum rudimental or wanting; cerebral hemispheres small and smooth).

But one deciduous molar tooth..................................2. *Marsupialia.*

aa. No marsupial bones; palate entire (one vagina; placenta and corpus callosum well developed).

β. Anterior limb reduced to more or less inflexible paddles, posterior limbs wanting (Mutilata).

No elbow joint; carpals discoid, and with the digits separated by cartilage; lower jaw without ascending ramus....................................3. *Cetacea.*

An elbow joint; carpals and phalanges with normal articulations; lower jaw with ascending ramus ....4. *Sirenia.*

ββ. Anterior limbs with flexible joints and distinct digits; ungual phalanges not compressed, and acute at apex[1] (Ungulata[2]).

γ. Tarsal bones in linear series; carpals generally in linear series.

Limbs ambulatory; teeth with enamel..........................5. *Taxeopoda.*[3]

γγ. Tarsal series alternating; carpal series linear.

Carpal series linear; no intermedium; fibula not interlocking with astragalus; no anapophyses; incisors rooted; hallux not opposable.............*Condylartha.*

Carpal series linear; an intermedium; fibula interlocking with astragalus; hallux not opposable ....*Hyracoidea.*

An intermedium; fibula not interlocking; anapophyses; hallux opposable; incisors growing from persistent pulps ....*Daubentonoidea.*

An intermedium; fibula not interlocking; anapophyses; hallux opposable; incisors rooted; carpus generally linear ....*Quadrumana.*

No intermedium;[4] nor anapophyses; carpal rows alternating; incisors rooted
Anthropoidea.

The only difference between the Taxeopoda and the Bunotheria is in the unguliform terminal phalanges of the former as compared with the clawed or unguiculate form in the latter. The marmosets among the former division are, however, furnished with typical claws.

Some may prefer to use the term Primates in place of Taxeopoda, and such may be the better course.

Cuboid bone partly supporting navicular, not in contact with astragalus
7. *Proboscidia.*

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[1] Except the Hapalidæ.

[2] Lamarck, Zoologie Philosophique, 1809.

[3] This order has the following suborders, whose association is now made for the first time.

[4] Except in Pithecus and Hylobates.

γγγγ. Both tarsal and carpal series more or less alternating.

Os magnum not supporting scaphoides; cuboid supporting astragalus; superior molars tritubercular.................. ....8. *Amblypoda.*

Os magnum supporting scaphoides; superior molars quadritubercular 9. *Diplarthra.*[1]

βββ. Anterior limbs with flexible joints. Ungual phalanges compressed and pointed[2] (Unguiculata).

ε. Teeth without enamel; no incisors.

Limbs not volant; hemispheres small, smooth......................10. *Edentata.*

εε. Teeth with enamel; incisors present.

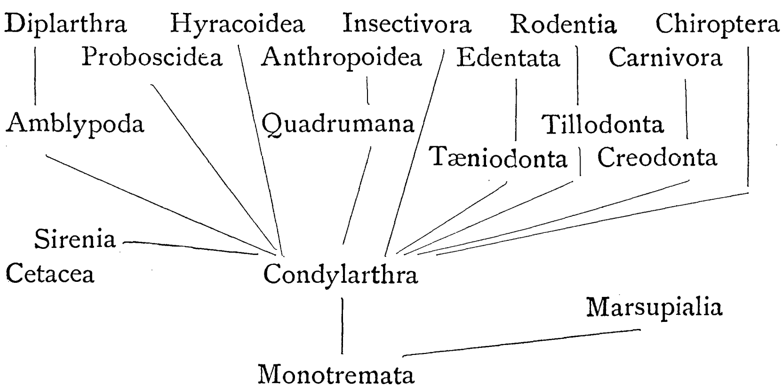
No postglenoid process; mandibular condyle round; limbs not volant; hemispheres small, smooth...11. *Rodentia.*

Limbs volant; hemispheres small, smooth ....12. *Chiroptera.*

A postglenoid process; mandibular condyle transverse; limbs not volant, no scapholunar bone;[3] hemispheres small, smooth...................13. *Bunotheria.*[4]

A postglenoid process; limbs not volant, with a scapholunar bone; hemispheres larger, convoluted ....14. *Carnivora.*

Palæontology has cleared up the phylogeny of most of these orders, but some of them remain as yet unexplained. This is the case with the Cetacea, the Sirenia and the Taxeopoda. The last-named order and the Marsupialia can be supposed with much probability to have come off from the Monotremata, but there is as yet no palæontological evidence to sustain the hypothesis. No progress has been made in unraveling the phylogeny of the Cetacea and Sirenia. The facts and hypotheses as to the phylogeny of the Mammalia may be represented in the following diagram :



[1] Except Pantolestes. This order includes the suborders Perissodactyla and Artiodactyla.

[2] Except Mesonyx.

[3] Except Erinaceus.

[4] With the suborders Insectivora, Creodonta, Tæniodonta and Tillodonta.

It will be readily seen from the above diagram that the discovery of the Condylarthra was an important event in the history of our knowledge of this subject. This suborder of the Lower Eocene epoch stands to the placental Mammalia in the same relation as the Theromorphous order does to the reptilian orders. It generalizes the characteristics of them all, and is apparently the parent stock of all, excepting perhaps the Cetacea. The discovery of the extinct Bunotherian suborders united together inseparably the clawed orders, excepting the bats; while the extinct order Amblypoda is the ancestor of the most specialized of the Ungulates, the odd and even-toed Diplarthra.

The characters of the skeleton of the order Monotremata show that it is nearest of kin to the Reptilia, and many subordinate characters point to the Theromorpha as its ancestral source.[1] In the general characters the Marsupialia naturally follow in a rising scale, as proven by the increasing perfection of the reproductive system. The Monodelphia follow with improvements in the reproductive system and the brain, as indicated in the table already given. The oldest Monodelphia were, in respect to the structure of the brain, much like the Marsupialia, and some of the existing orders resemble them in some parts of their brain-structure. Such are the Condylarthra and Amblypoda of extinct groups, and the Bunotheria, Edentata, Rodentia and Chiroptera, recent and extinct. The characters of the brains of Amblypoda and some Creodonta are, in their superficial characters, even inferior to existing marsupials. The divided uterus of these recent forms also gives them the position next to the Marsupialia. In the Carnivora, Hyracoidea and Proboscidia a decided advance in both brain structure and reproductive system is evident. The hemispheres increase in size and they become convoluted. A uterus is formed and the testes become external, etc. In the Quadrumana the culmination in these parts of the structure is reached, excepting only that in the lack of separation of the genital and urinary efferent ducts, the males are inferior to those of many of the Artiodactyla. This history displays a rising scale for the Mammalia.

Looking at the skeleton we observe the following successional modifications:[2]

[1] Proceedings American Philosoph. Society, 1884, p. 43.

[2] See the evidence for evolution in the history of the extinct Mammalia. Proceeds. Amer. Assoc. Adv. Science, 1883.

First, as to the feet, and (A) the digits. The Condylarthra have five digits on both feet, and they are plantigrade. This character is retained in their descendants of the lines of Anthropoidea, Quadrumana and Hyracoidea, also in the Bunotheria, Edentata and most of the Rodentia. In the Amblypoda and Proboscidia the palm and heel are a little raised. In the Carnivora and Diplarthra the heel is raised, often very high, above the ground, and the number of toes is diminished, as is well known, to two in the Artiodactyla and one in the Perissodactyla. (B) The tarsus and carpus. In the Condylarthra the bones of the two series in the carpus and tarsus are opposite each other, so as to form continuous and separate longitudinal series of bones. This continues to be the case in the Hyracoidea and many of the Quadrumana, but in the anthropoid apes and man the second row is displaced inwards so as to alternate with a first row, thus interrupting the series in the longitudinal direction, and forming a stronger structure than that of the Condylartha. In the Bunotherian rodent and edentate series, the tarsus continues to be without alternation, as in the Condylarthra, and is generally identical in the Carnivora. In the hoofed series proper it undergoes change. In the Proboscidia the carpus continues linear, while the tarsus alternates. In the Amblypoda the tarsus alternates in another fashion, and the carpal bones are on the inner side linear, and on the outer side alternating. The complete interlocking by universal alternation of the two carpal series is only found in the Diplarthra. (C) As to the ankle-joint. In most of the Condylarthra it is a flat joint or not tongued or grooved. In most of the Carnivora, in a few Rodentia, and in all Diplarthra, it is deeply tongued and grooved, forming a more perfect and stronger joint than in the other orders, where the surfaces of the tibia and astragalus are flat. (D) In the highest forms of the Rodentia and Diplartha the fibula and ulna become more or less coössified with the tibia and radius, and their middle portions become alternated or disappear.

Secondly, as regards the vertebræ. The mutual articulations (zygapophyses) in the Condylartha are flat and nearly horizontal. In higher forms, especially of the ungulate series, they become curved, the posterior turning upwards and outwards, and the anterior embracing them on the external side. In the higher Diplartha this curvature is followed by another curvature of the

postzygapophysis upwards and outwards, so that the vertical section of the face of this process is an S. Thus is formed a very close and secure joint, such as is nowhere seen in any other Vertebrata.

Thirdly, as regards the dentition. Of the two types of Monotremata, the Tachyglossidæ and the Platypodidæ, the known genera of the former possess no teeth, and the known genus of the latter possesses only a single corneous epidermic grinder in each jaw. As the Theromorphous reptiles from which these are descended have well developed teeth, their condition is evidently one of degeneration, and we can look for well toothed forms of Monotremata in the beds of the Triassic and Jurassic periods. Perhaps some such are already known from jaws and teeth. In the marsupial order we have a great range of dental structure, which almost epitomizes that of the Monodelph orders. The dentition of the carnivorous forms is creodont; of the kangaroos is perissodactyle, and that of the wombats is rodent. Other forms repeat the Insectivora. I therefore consider the placental series especially. I have already shown that the greater number of the types of this series have derived the characters of their molar teeth from the stages of the following succession. First a simple cone or reptilian crown, alternating with that of the other jaw. Second, a cone with lateral denticles. Third, the denticles to the inner side of the crown forming a three-sided prism, with tritubercular apex, which alternates with that of the opposite jaw. Fourth, development of a heel projecting from the posterior base of the lower jaw, which meets the crown of the superior, forming a tubercular-sectorial inferior molar. From this stage the carnivorous and sectorial dentition is derived, the tritubercular type being retained. Fifth, the development of a posterior inner cusp of the superior molar and the elevation of the heel of the inferior molar, with the loss of the anterior inner cusp. Thus the molars become quadritubercular, and opposite. This is the type of many of the Taxeopoda, including the Quadrumana and Insectivora as well as the inferior Diplarthra. The higher Taxeopoda (Hyracoidea) and Diplarthra add various complexities. Thus the tubercles become flattened and then concave, so as to form Vs in the section produced by wearing, or they are joined by cross-folds, forming various patterns. In the Proboscidia they become multiplied so as to produce numerous cross-crests.

The dentition of some of the Sirenia is like that of some of the Ungulata, especially of the suilline group, while in others the teeth consist of cylinders. In the Cetacea the molars of the oldest (Eocene and Miocene) types are but two-rooted and compressed, having much the form of the premolars of other Mammalia. In existing forms a few have simple conical teeth, while in a considerable number teeth are entirely wanting.

A review of the characters of the existing Mammalia as compared with those of their extinct ancestors displays a great deal of improvement in many ways, and but few instances of retrogression. The succession in time of the Monotremata, the Marsupialia, and the Monodelphia, is a succession of advance in all the characters of the soft parts and the skeleton which define them (see table of classification). As to the monotremes themselves, it is more than probable that the order has degenerated in some respects in producing the existing types. The history of the Marsupialia is not made out, but the earliest forms of which we know the skeleton, Polymastodon (Cope) of the Lower Eocene, is as specialized as the most specialized recent forms. The dentition of the Jurassic forms, Plagiaulax, etc., is quite specialized also, but not more so than that of the kangaroos. The premolars are more specialized, the true molars less specialized than in those animals.

Coming to the Monodelphia the increase in the size and complication of the brain, both of the cerebellum and the hemispheres, is a remarkable evidence of advance. But one retrogressive line in this respect is known, viz., that of the order Amblypoda,[1] where the brain has become relatively smaller with the passage of time. The successive changes in the structure of the feet are all in one direction, viz., in the reduction of the number of the toes, the elevation of the heel and the creation of tongue and groove joints where plain surfaces has previously existed. The diminution in the number of toes might be regarded as a degeneracy, but the loss is accompanied by a proportional gain in the size of the toes that remain. In every respect the progressive change in the feet is an advance. In the carpus and tarsus we have a gradual rotation of the second row of bones on the first, to the inner side. In the highest and latest orders this process is most complete, and as it results in a more

[1] See NATURALIST, Jan., 1885, p. 55.

perfect mechanical arrangement, the change is clearly an advance. The same progressive improvement is seen in the development of distinct facets in the cubito-carpal articulation, and of a tongue and groove ("intertrochlear crest") in the elbow-joint. In the vertebræ the development of the interlocking zygapophysial articulations is a clear advance.

Progress is generally noticeable in the dental structures; unlike the marsupial line the earliest dentitions are the most simple, and the later the more complex. Some of the types retain the primitive tritubercular molars, as the Centetidæ, shrews and some lemurs, and many Carnivora, but the quadritubercular and its derivative forms is by far the most common type in the recent fauna. The forms that produced the complicated modifications in the Proboscidia and Diplarthra appeared latest in time, and the most complex genera, Bos and Equus, the latest of all. The extreme sectorial modifications of the tritubercular type, as seen in the Hyænidæ and the Felidæ, are the latest of their line also.

Some cases of degeneracy are, however, apparent in the monodelphous Mammalia. The loss of pelvis and posterior limbs in the two mutilate orders is clearly a degenerate character, since there can be no doubt but that they have descended from forms with those parts of the skeleton present. The reduction of flexibility seen in the limbs of the Sirenia and the loss of this character in the fore limbs of the Cetacea are features of degeneracy for the same reason. The teeth in both orders have undergone degenerate evolution, to extinction in the later and existing forms of the Cetacea. The Edentata appears to have undergone degeneration. This is chiefly apparent in the teeth which are deprived of enamel, and which are wanting from the premaxillary bone. A suborder of the Bunotheria, the Tæniodonta of the Lower Eocene period, display a great reduction of enamel on the molar teeth, so that in much worn examples it appears to be wanting. Its place is taken by an extensive coat of cementum, as is seen in Edentata, and the teeth are ever rootless as in that order. It is probable that the Edentata are the descendants of the Tæniodonta by a process of degeneracy.

Local or sporadic cases of degenerate loss of parts are seen in various parts of the mammalian series, such are toothless Mammalia wherever they occur. Such are cases where the teeth become extremely simple, as in the honey-eating marsupial Tarsipes,

ERRATUM FOR APRIL NATURALIST.

Owing to the absence from the country of both the leading editors during last month, some typographical errors occur in the last number of the NATURALIST. The most important of these is on page 346, where a foot-note containing the classification of the Taxeopoda is included in the text of the classification of the Mammalia. Therefore, p. 346, lines two to eighteen from bottom, transfer to foot of page, under note 3. Ibid. bottom line, change " 7 " to 6, and numbers in following lines to coincide.

the carnivore Proteles, the Pteropod bats, and the aye-aye. Also where teeth are lost from the series, as in the canine genus Dysodus, and in man. The loss of the hallux and pollex without corresponding gain, in various genera, may be regarded in the same light.

In conclusion, the progressive may be compared with the retrogressive evolution of the Vertebrata, as follows: In the earlier periods and with the lower forms, retrogressive evolution predominated. In the higher classes progressive evolution has predominated. When we consider the history of the first class of vertebrates, the Tunicata, in this respect, and compare it with that of the last class, the Mammalia, the contrast is very great.

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PROGRESS OF NORTH AMERICAN INVERTEBRATE PALÆONTOLOGY FOR 1884.

BY J. B. MARCOU.

THE year that has just passed has been fairly prolific in palæontological work, about fifteen more titles appearing in this review than there were in the last; it is true that a few of them should have been inserted last year, but doubtless some titles have escaped me also this year, and the two errors may be considered to compensate each other; so that we have an increase of about one-third in the number of articles published. There is also a general improvement in the quality of illustrations, though of course there is still plenty of room for improvement, and it is surprising that some palæontologists should persist in publishing a large number of descriptions with no illustrations at all, or with such imperfect illustrations as to render them practically useless; the chief result brought about by such publication of species is an increase of our already voluminous synonymy. The day will doubtless come when descriptions of new species unaccompanied by proper diagnoses and illustrations will no longer be recognized, for it is next to impossible to recognize a form from a meager description unaccompanied by an illustration. The founding of new genera and species on very imperfect specimens is also a very reprehensible practice, for although it may be excellent exercise for the imagination of the author, yet it may introduce errors which it will take a great deal of time and trouble to eradicate, especially when there is no indication that such descriptions